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observer of the general anatomical characteristics of his subjects, never examined the sternum of the adult *G. americana*, but only of what he considered the young. Yet we must conclude this to have been the case, for had it been otherwise, we certainly should not have been left with only the above description given without comment.

In conclusion, I cannot refrain from alluding to a subject which it were better, perhaps, to leave untouched at this time. In making careful, detailed comparisons of the several sterna in my possession, in order to determine exactly in what particulars the two species differ, I could but notice that only two important conditions need be fulfilled to change the sternum of *canadensis* into that of *americana*. If the remaining portion of the keel in *canadensis* were thickened and hollowed, and the trachea should gradually increase in length, the arrangement seen in *americana* would certainly result, for the disposition of the trachea in the latter species is exactly what would be produced by its forcing itself into the narrow limits of the keel. This may be simply an interesting relationship existing between the two structures, or it may have a deeper significance as the nature of the variations among the sterna of *canadensis* pointed out above, seems to imply. But considerations of this nature must be left for further investigation—until material of a determinative kind has been obtained.

EXPLANATION OF CUTS.

FIG. 1.—Sternum and lower part of trachea of the sandhill crane, *G. canadensis*. The left wall of the cavity has been removed, showing the trachea coiled away inside.

FIG. 2.—The same of the whooping crane, *G. americana*. The entire left side of the keel has been cut away to show the interior. The scapulars, clavicles and coracoids are in position in each.

These drawings were very kindly made for the illustration of this article by my friend, Mr. C. L. Herrick. They are about one-half natural size.

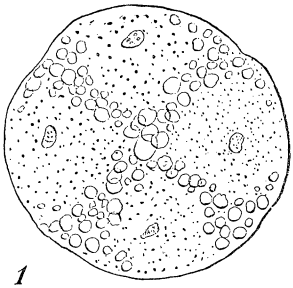
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THE DEVELOPMENT OF MOINA.[1]

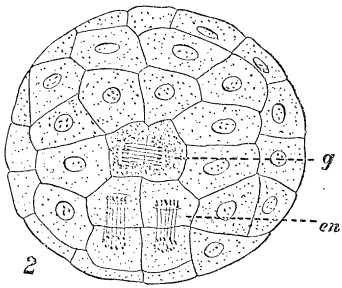
BY J. S. KINGSLEY.

DR. Carl Grobben having recently published one of the most complete accounts of the development of one of the Daphnidæ which has yet appeared, an abstract of his paper may prove of value to American naturalists.

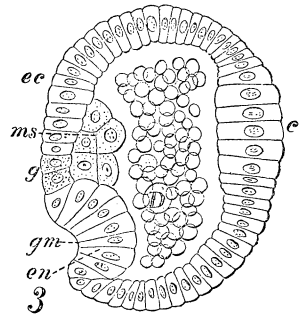
[1] Die Entwickelungsgeschichte der *Moina rectirostris*. Arbiten aus dem Zoologischen Institute der Universität. Wien. Tom. II, 2 heft, 1879, pp. 66, pls. 7.



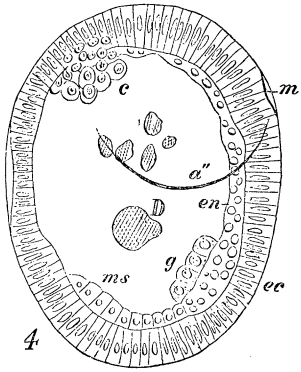
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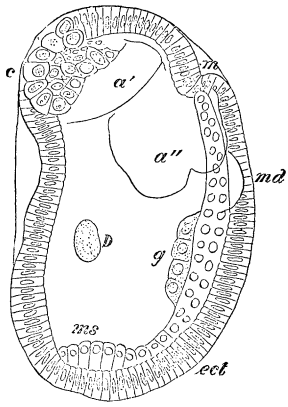
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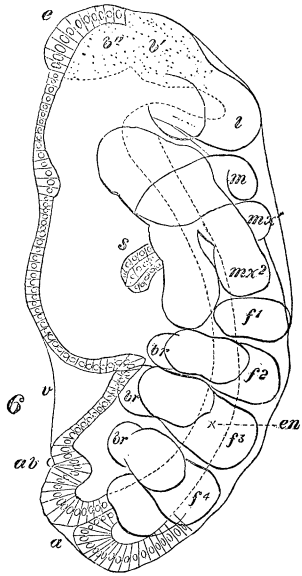
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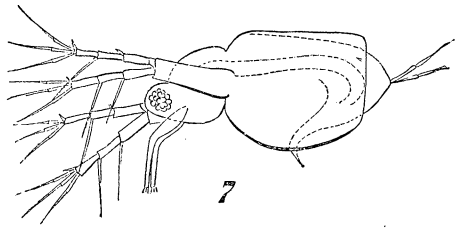
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The eggs of Moina are oval and measure about one-tenth of a millimetre in length. Segmentation occurs first on the minor and then on the major axis, thus producing four cleavage spheres. A polar view of these is shown in Fig. 1, the food granules (*deutoplasm*) being seen between the blastomeres. Another division produces eight segments, but after this, cleavage takes place at unequal rates in different parts of the egg. As we understand the matter, these cleavage planes do not all pass completely through the yolk. In the resulting mulberry stage the "genital cell" (which afterwards produces the genital system) is differentiated even before the first signs of the gastrula stage. (Fig. 2 *g*, genital cells or the cells which by invagination produce the endoderm. In these cells the so-called *Amphiaster* is shown.) Soon there begins an invagination of the endodermal cells, and other cells arise beneath the ectodermal cells near the genital cells. These form the mesoderm. Others, opposite the genital cells, are larger, and these form the cephalic germinal plate, "scheitel platte." (Fig. 3, an optical section; *ec*, ectoderm; *ms*, mesoderm; *g*, genital cells; *g m*, gastrula mouth; *en*, the cells which form the endoderm; *c*, cephalic germinal plate; *D*, deutoplasm.) Then the gastrula mouth closes up, the genital and endodermal cells become internal, the body is constricted and a fold is formed on either side, the first indication of appendages, which develops into the second antennæ. A depression occurs in the ectodermal cells, where finally the mouth appears. (Fig. 4, lettering as before; *a''*, second antennæ; *m*, depression for mouth.) In the next phase two more appendages have budded, the antennulæ and mandibles, while the antennal bud becomes two-lobed. This constitutes the nauplius stage. (Fig. 5, *a'*, antennulæ; *md*, mandible.) Next, two of the thoracic feet are indicated, then two more, the brain begins to appear, the mouth depression is deeper, the anus is indicated and the genital cells divide and are placed on each side of the median line. Then the maxillæ and the fifth pair of feet appear; the eye begins to be developed from the ectodermal cells, the shell gland is present and the abdominal bristles are outlined. (Fig. 6, *b' b''*, brain; mx^1 mx^2, first and second maxillæ; f^1–f^5, thoracic feet; *br*, branchial sacs; *ab*, abdominal bristles; *a*, anus; *s*, shell gland; *v*, vitelline membrane; other letters as before.) The succeeding changes are those of increase in size of the appendages, in which joints appear, the formation of the shell, appearance of heart and the covering of the eye, and at last the animal acquires the perfect form (Fig. 7, from Baird).